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Technical Memorandum
Contaminants of Potential Concern to Sample for Soil and Vegetation
at Ballard, Henry, and Enoch Valley Mines
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Below are the Agencies and Tribes recommendations, along with the rationale, for analytes to be sampled for soil and vegetation on waste rock dumps and mine pits at Ballard, Henry, and Enoch Valley mines.

+ Flow
+ Screening process overview & rationale
+ Conclusions

Statement of Work

In the 29 May 08 conference call, P4/Monsanto recommended a list of analytes for which soil and vegetation would be sampled at Ballard, Henry, and Enoch Valley mines. The list included those analytes identified in the CO/AOC (EPA Docket No. CERCLA-10-2003-0117) Statement of Work (Task 3.D): cadmium, chromium, copper, nickel, selenium, vanadium, and zinc. They also suggested sampling for molybdenum and copper because of the concern of the interaction between the two metals and the potential for molybdenosis.

9 COPCs

Ballard, Henry, and Enoch Valley Soil Concentrations

Sampling of various analytes took place in 1998 (July), 2000 (summer; Enoch Valley Mine only), 2001 (May and August-September) and 2004 (July). The resultant data were compared to background concentrations from the western United States (Table 1). Maximum concentrations of antimony, arsenic, beryllium, chromium, copper, manganese, molybdenum, nickel, selenium, uranium, vanadium, and zinc exceeded twice the mean western U. S. concentration (Shacklette and Boerngen 1984 cited in Tetra Tech EM 2002).

Chemical Composition of Waste Rock Dumps

Soil

The USGS published a report in 2001 (Moyle and Causey 2001) that examined the chemical composition of waste rock dumps in Idaho, Wyoming, and Utah. Seven contaminants were identified whose average concentration was moderately (1.5-5.6 times) elevated above the world-wide average for shale. These contaminants included: arsenic, antimony, thallium, chromium, copper, nickel, and vanadium. In addition, four other contaminants – selenium, cadmium, molybdenum, and zinc – greatly (12-172 times) exceeded the world-wide shale average. Further examination of the report also showed above average levels of silver, strontium, and several rare earth metals (europium, holmium, lanthanum, neodymium, yttrium, and ytterbium) in the waste rock dumps.

BLM Risk Management Criteria

Ford (2004) looked at risk management for metals at BLM mining sites. Eleven contaminants of concern were identified by Ford for human health risk: antimony, arsenic, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc. He assumed that ingestion of soil, sediment, and plants to be the predominant source of exposure of metals for wildlife receptors. Arsenic, cadmium, copper, lead, mercury, and zinc were included in the ecological assessment.

Not rely totally on eco SSLs →

From reviews

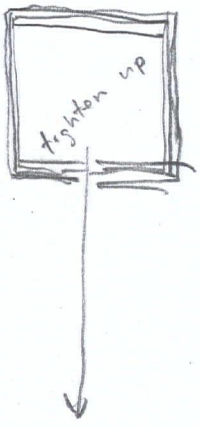
Overall idea & process reasonable

Human Health and Ecological Screening Levels

Based on the above, the following analytes were chosen to evaluate against human health (ORNL website) and ecological (EPA website) screening levels (Table 2): antimony, arsenic, beryllium, cadmium, chromium, copper, manganese, molybdenum, nickel, selenium, silver, uranium, vanadium, and zinc. Aluminum, barium, lead, mercury and thallium were not used in the comparison as they did not exceed background levels (Table 1). Screening levels were not available for strontium and the rare earth metals.

QA ↓

Concentrations at the three mines of these COPCs were then compared to Oak Ridge National Laboratory human health screening levels (ORNL website) and ecological soil screening levels (EPA website). Human health screening levels were exceeded for only two contaminants – arsenic and chromium. (Note that chromium was not speciated so the assumption was made that all the chromium was in the Cr VI state.) Molybdenum and uranium, for which there are no ecological soil screening levels, did not exceed the human health soil screening level. There were no exceedances of human health or ecological soil screening levels for beryllium.



Recommended list of analytes for soil sampling

From the 14 COPCs screened for human health and ecological screening levels, the following are recommended for evaluation as part of the sampling of soil at waste rock dumps and mine pits at Ballard, Henry, and Enoch Valley mines: antimony, arsenic, cadmium, chromium, copper, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc. Beryllium was dropped as it did not exceed any human health or ecological screening level. There are no ecological screening levels for molybdenum and uranium and neither metal exceeded human health screening level for soil. Uranium was eliminated while molybdenum was retained due to its interaction with copper.

Recommended list of analytes for vegetation sampling

The recommended list of analytes for which to sample vegetation are arsenic, cadmium, copper, manganese, nickel, selenium, and zinc. These seven contaminants exceeded the ecological screening levels for plants (Table 3). Four of these contaminants (arsenic, cadmium, copper, and zinc) were also identified by Ford (2004) as contaminants of concern when considering risk to wildlife and livestock.

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Table 1. Comparison of soil concentrations from Ballard, Henry, and Enoch Valley mines to background concentrations from western United States (from Shacklette and Boerngen 1984 cited in Tetra Tech EM 2002). Maximum concentrations at the individual mines were compared to two times the mean western U. S. concentration.

Analyte	Background (mg/kg dw)	Exceedance of Background[1]		
		Ballard	Henry	Enoch Valley
Aluminum	58,000	No	No	No
Antimony	0.47	Yes	Yes	Yes
Arsenic	5.5	Yes	Yes	Yes
Barium	580	No	No	No
Beryllium	0.68	Yes	Yes	Yes
Chromium	41	Yes	Yes	Yes
Copper	21	Yes	Yes	Yes
Lead	17	No	No	No
Manganese	380	No	No	Yes
Mercury	0.46	No	No	No
Molybdenum	0.85	Yes	Yes	Yes
Nickel	15	Yes	Yes	Yes
Selenium	0.23	Yes	Yes	Yes
Thallium	9.1	No	No	No
Uranium	3.0	Yes	Yes	Yes
Vanadium	70	Yes	Yes	Yes
Zinc	55	Yes	Yes	Yes

[1]maximum concentrations exceedance of two times background concentration

Table 2. Screening levels for human health and ecological receptors.

Analyte	ORNL screening levels, industrial soil[1] (mg/kg)	EcoSSL[2] (mg/kg)			
		Plants	Soil inverts	Avian	Mammalian
Antimony	410	NA[3]	78	NA	0.27
Arsenic	1.60	18	NA	43	46
Beryllium	2,000	NA	40	NA	21
Cadmium	810	32	140	0.77	0.36
Chromium					
Cr III	1,500,000	--	--	26	34
Cr VI	1,400	--	--	NA	130
Copper	41,000	70	80	28	49
Manganese	--	220	450	4300	4000
Molybdenum	5,100	none			
Nickel	20,000	38	280	210	130
Selenium	5,100	0.52	4.1	1.2	0.63
Silver	5,100	560	NA	4.2	14
Uranium	3,100	none			
Vanadium	5,200	NA	NA	7.8	280
Zinc	310,000	160	120	46	79

[1]Oak Ridge National Laboratory screening levels for chemical contaminants
[2]EPA ecological soil screening levels
[3]NA=not available, data were insufficient to derive Eco-SSL
[4]residential value (no industrial value)

Table 3. Occurrence of exceedances of soil screening levels of various contaminants from 1998, 2000, 2001, and 2004 sampling events at Ballard, Henry, and Enoch Valley mines.

Analyte	Ballard Mine					Henry Mine					Enoch Valley Mine				
	Human Health	Plants	Soil Inverts	Avian	Mammalian	Human Health	Plants	Soil Inverts	Avian	Mammalian	Human Health	Plants	Soil Inverts	Avian	Mammalian
Antimony	No	--	No	--	Yes	No	--	No	--	Yes	No	--	No	--	Yes
Arsenic	Yes	Yes	--	Yes	No	Yes	Yes	--	Yes	Yes	Yes	Yes	--	Yes	Yes
Beryllium	No	--	No	--	No	No	--	No	--	No	No	--	No	--	No
Cadmium	No	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Chromium	No	--	--	Yes	Yes	No	--	--	Yes	Yes	Yes	--	--	Yes	Yes
Copper	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Manganese	--	Yes	Yes	No	No	--	Yes	Yes	No	No	--	Yes	Yes	Yes	Yes
Molybdenum	No	--	--	--	--	No	--	--	--	--	No	--	--	--	--
Nickel	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Selenium	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Silver	No	No	--	Yes	No	No	No	--	Yes	No	No	No	--	Yes	No
Uranium	No	--	--	--	--	No	--	--	--	--	No	--	--	--	--
Vanadium	No	--	--	Yes	Yes	No	--	--	Yes	Yes	No	--	--	Yes	Yes
Zinc	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

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1) lowest screening values of all

2) max site conc data

→ Need single COPC list

→ multiple lists not really appropriate

→ cumulative risk of all receptors

→ eliminating pathways/receptors

References

EPA (Environmental Protection Agency). Ecological soil screening levels. Available: www.epa.gov/ecotox/ecossl/. (May 2008).

Ford, K. L. 2004. Risk management criteria for metals at BLM mining sites. Bureau of Land Management, National Science and Technology Center, Technical Note 390 (revised), Denver, CO.

Moyle, P. R., and J. D. Causey. 2001. Chemical composition of samples collected from waste rock dumps and other mining-related features at selected phosphate mines in southeastern Idaho, western Wyoming, and northern Utah. United States Geological Survey, Open-File Report 01-410, Washington, DC.

ORNL (Oak Ridge National Laboratory). Screening levels for chemical contaminants. Available: epa-prgs.ornl.gov/chemicals/download.shtml. (May 2008).

Shacklette, H.T., and J.G. Boerngen. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. U.S. Geological Survey Professional Paper 1270, Washington, DC.

Tetra Tech EM. 2002. Final area wide human health and ecological risk assessment. Report to Idaho Department of Environmental Quality, Pocatello, ID.